Module 4 - Strain Gauges

ME3050 - Dynamics Modeling and Controls

Mechanical Engineering

Tennessee Technological University

Topic 2 - The Wheatstone Bridge

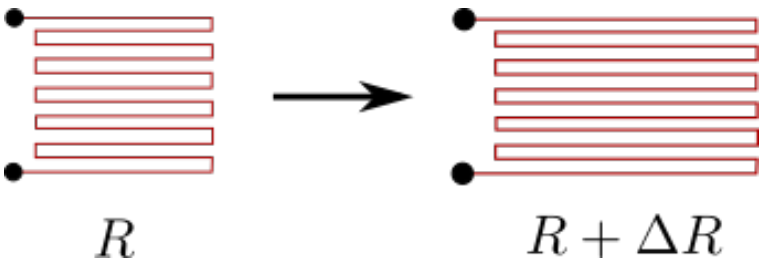
Topic 2 - The Wheatstone Bridge

- Resistive Gauges
- The Bridge Circuit
- Quarter, Half and Full Bridges
- Gauge Configuration Benefits

Resistive Gauges

The resistive strain gauge is bonded to the surface so that is deforms with the specimen. The change in length of the bonded gauge causes a change in resitance which is used as a measure of strain.

$$R = \rho_e L / A_c = fn(L, ...)$$



This is an exagerated picture so the change is very small...

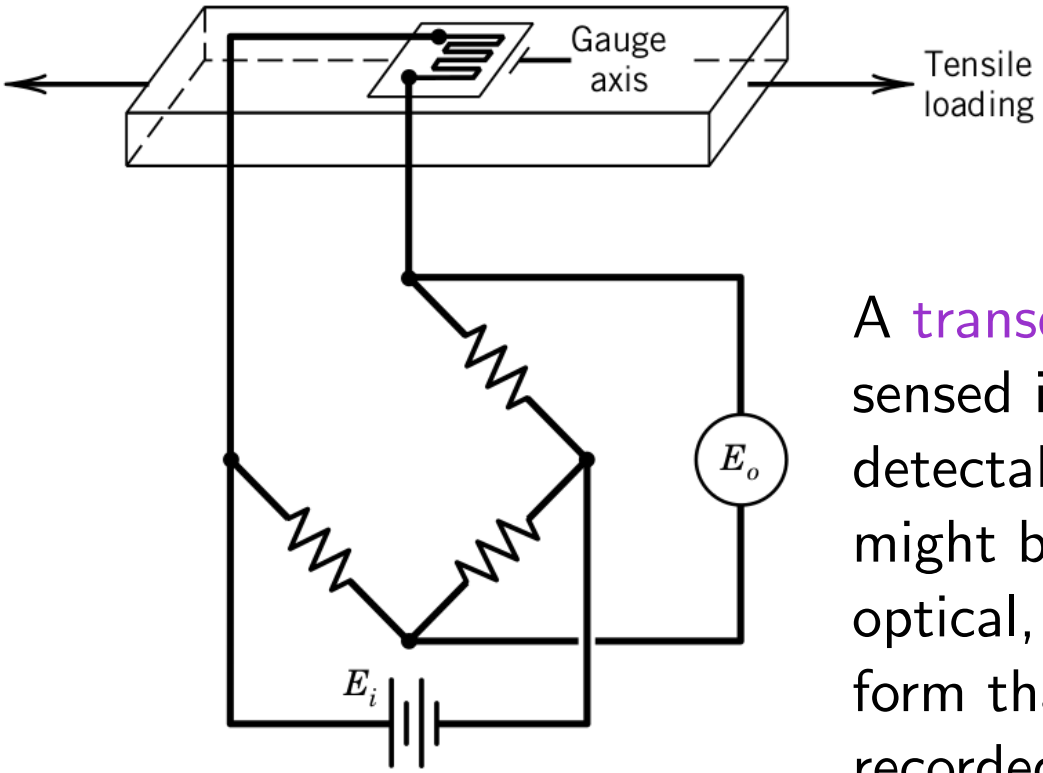
Resistive Gauges

The Gauge Factor is typically used instead of the physical parameters.

$$GF \equiv \frac{\delta R/R}{\delta L/L} = \frac{\delta R/R}{\epsilon_a}$$

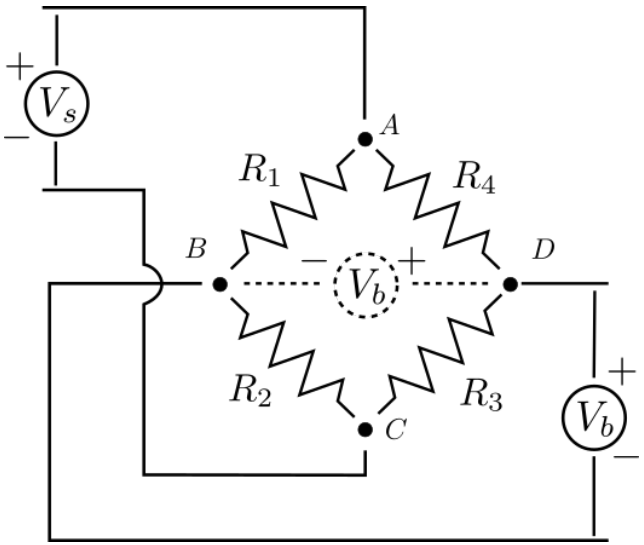
This number relates the relative change in resistance to the meausured strain.

The Bridge Circuit



A transducer converts the sensed information into a detectable signal. The signal might be mechanical, electrical, optical, or may take any other form that can be meaningfully recorded.

The Bridge Circuit

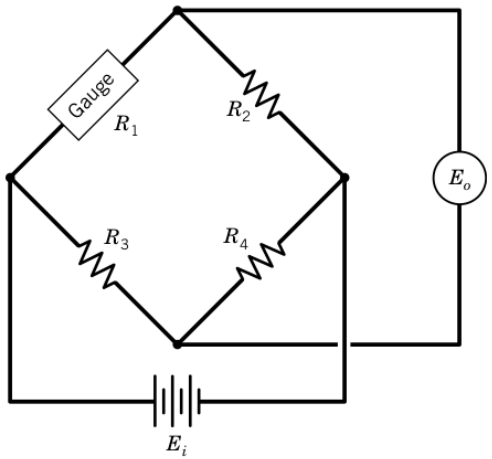


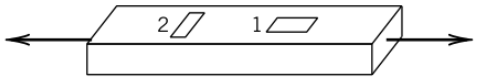
How does the bridge circuit work as a transducer?

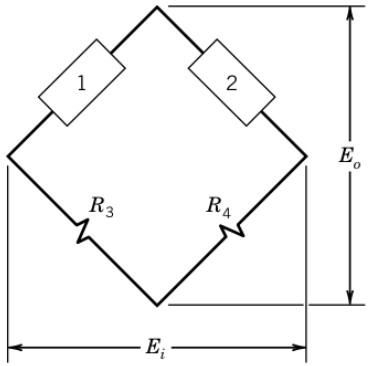
Use KVL and the voltage divider rule find the relationship between the two voltages.

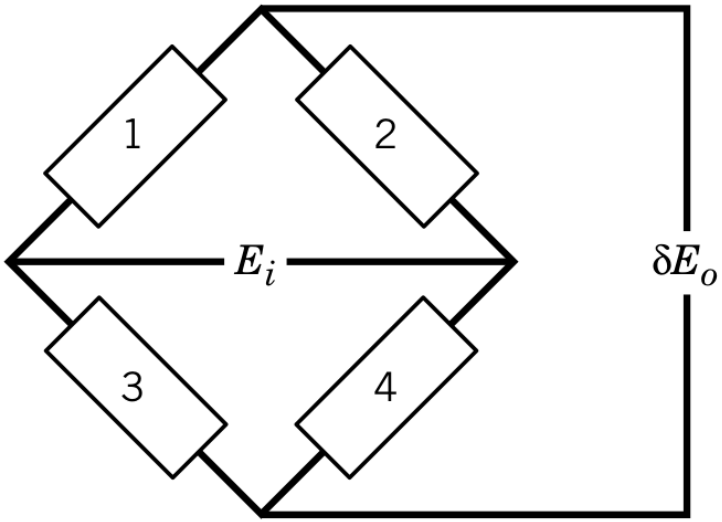
$$V_b = \left(\frac{R_3}{R_3+R_4} - \frac{R_2}{R_1+R_2} \right) \times V_s$$

Quarter, Half and Full Bridges

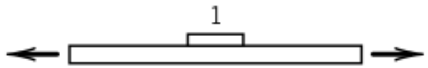
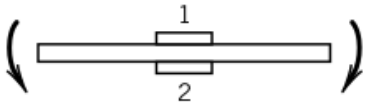
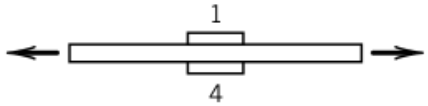
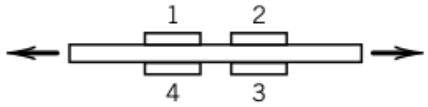
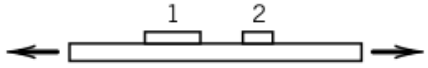
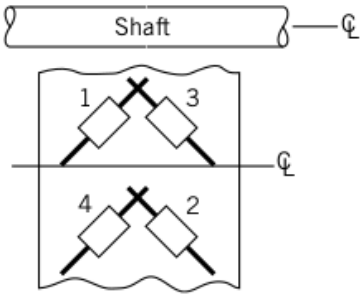








Gauge Configuration Benefits

	Arrangement	Compensation Provided	Bridge Constant κ
	Single gauge in uniaxial stress	None	$\kappa = 1$
	Two gauges sensing equal and opposite strain—typical bending arrangement	Temperature	$\kappa = 2$
	Two gauges in uniaxial stress	Bending only	$\kappa = 2$
	Four gauges with pairs sensing equal and opposite strains	Temperature and bending	$\kappa=4$
	One axial gauge and one Poisson gauge		$\kappa= 1 +\nu$
	Four gauges with pairs sensing equal and opposite strains—sensitive to torsion only; typical shaft arrangement.	Temperature and axial	$\kappa = 4$